

A

11/13/97



jc546
U.S. PTO

Attorney's Docket No. 002240.P048

Patent

ASSISTANT COMMISSIONER FOR PATENTS
Washington, D.C. 20231

SIR: Transmitted herewith for filing is the **nonprovisional patent application** of

Inventor(s): Peter L. Froeberg

For: EXTENSIBLE GPS RECEIVER SYSTEM

(Title)

Enclosed are:

- ☒ Twelve (12) sheet(s) of Drawings.
- ☒ An Assignment of the invention to _____.
- ☒ Assignment Cover Sheet Form PTO-1595.
- ☒ A Declaration and Power of Attorney (☒ signed/ _____ unsigned).
- ☒ A Verified Statement to establish Small Entity Status under 37 C.F.R. §§ 1.9 and 1.27.
- ☒ Power of Attorney

The Filing Fee has been calculated as shown below:

		(Col. 1)		(Col. 2)		SMALL ENTITY		OTHER THAN A SMALL ENTITY	
For:	No. Filed			No. Extra		Rate	Fee	Rate	Fee
Basic Fee:							\$ 395		\$ 790
Total Claims:	13	- 20	*	0		x 11	\$	x 22	\$ 0
Indep. Claims:	3	- 3	*	0		x 41	\$	x 82	\$ 0
<div></div>	Multiple Dependent Claim(s) Presented					+ 135	\$	+ 270	\$
* If the difference is less than zero, enter "0" in Col. 2.						TOTAL	\$	TOTAL	\$ 790

* If the difference is less than zero, enter "0" in Col. 2.

- ☒ A check for \$ 790.00 for the filing fee is enclosed.
- ☒ A check for \$ 40.00 for recordation of the Assignment is enclosed.

"Express Mail" mailing label number: EM335897944US

Date of Deposit: 11/13/97

I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to the Assistant Commissioner for Patents, Washington, D. C. 20231

JENNIFER C. PASK

(Typed or printed name of person mailing paper or fee)

(Signature of person mailing paper or fee)

(Date signed)

X The Commissioner of Patents and Trademarks is hereby authorized to charge payment of the following fees associated with this communication, or credit any overpayment, to our Deposit Account No. 02-2666. **A duplicate copy of this sheet is enclosed.**

 X Any additional filing fees required under 37 C.F.R. § 1.16.

 X Any patent application processing fees under 37 C.F.R. § 1.17.

 X The Commissioner of Patents and Trademarks is hereby authorized to charge payment of the following fees during the pendency of this application, or credit any overpayment, to our Deposit Account No. 02-2666. **A duplicate copy of this sheet is enclosed.**

 X Any processing fees under 37 C.F.R. § 1.17, including any extension fees.

 X Any filing fees under 37 C.F.R. § 1.16 for presentation of extra claims.

 X Send all correspondence to the undersigned at BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, 12400 Wilshire Boulevard, Seventh Floor, Los Angeles, California 90025, and direct all telephone calls to the undersigned at (408) 720-8598.

Respectfully submitted,

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP

Date: November 13, 1997

By Maria McCormack Sobrino
Maria McCormack Sobrino

Reg. No.: 31,639

12400 Wilshire Boulevard
Seventh Floor
Los Angeles, California 90025
(408) 720-8598

002240.P048

PATENT

UNITED STATES PATENT APPLICATION
FOR
EXTENSIBLE GPS RECEIVER SYSTEM

INVENTORS:

PETER L. FROEBERG

PREPARED BY:

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
12400 WILSHIRE BOULEVARD
SEVENTH FLOOR
LOS ANGELES, CA 90025-1026

(408) 720-8598

"Express Mail" mailing label number EM335897944US

Date of Deposit November 13, 1997

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231

JENNIFER C. TASK
(Typed or printed name of person mailing paper or fee)

Jennifer C. Task
(Signature of person mailing paper or fee)

11/13/97
Date

EXTENSIBLE GPS RECEIVER SYSTEM

BACKGROUND OF THE INVENTION

5 FIELD OF THE INVENTION

The present invention relates to a mechanism for processing positioning signals such as those received from the Global Positioning System (GPS).

10

ART BACKGROUND

15

The global positioning system (GPS) has become extremely popular for a number of applications. GPS receivers are now incorporated into a variety of systems including consumer electronic systems in which the location information or time information provided by GPS supplements the other information provided by the system. Thus, more and more industries are realizing the advantages that GPS can provide.

20

Typically, when a customer, such as an original equipment manufacturer (OEM) develops a particular application of GPS, the GPS manufacturer generates the application code in accordance with the customer's specification. The GPS manufacturer designs and codes the user application of GPS, as the processing performed by the GPS receiver has strict timing and processing requirements that cannot be disturbed by other processing such as the user application processing. Unless carefully written, the execution of customer code can conflict with the GPS processing code. In addition, there is the danger of the user code overriding sections of memory

25

containing the GPS processing code or GPS data used in processing. Thus, the GPS manufacturer cognizant of these restrictions carefully develops the user application code for a particular customer. This is a time consuming and costly process. It is therefore desirable to develop a system that insulates

5 the GPS processing portion and data from the user application portion such that the user application portion has access to the positioning data generated by the GPS processing portion without the concern that the user application portion will corrupt the GPS processing portion and data of the receiver.

Patent 6,363,360

SUMMARY OF THE INVENTION

The apparatus and method of the present invention provides a processing system in which the processor is coupled to a Global Positioning
5 System (GPS) receiver circuitry that receives positioning signals and, in
accordance with well known GPS processing techniques, generates the
positioning data for access by a user application process executing on the
same processor. A firewall is established between the user application
process and the GPS process. The firewall prevents the user application
10 process from conflicting with time critical processing by the GPS process and
further prevents the user application process from overriding the memory
areas allocated to the GPS process.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, features and advantages of the present invention will be apparent to one skilled in the art from the following detailed description in
5 which:

Figure 1 is a simplified block diagram of one embodiment of the system of the present invention.

Figure 2 is a block diagram illustrating the structure of the processes in accordance with the teachings of the present invention.

10 **Figures 3a and 3b** illustrate one class of GPS objects in accordance with the teachings of the present invention.

Figures 4a, 4b, 4c, 4d, 4e, 4f and 4g illustrate another class of GPS objects in accordance with the teachings of the present invention.

15 **Figures 5a and 5b** illustrate a class of GPS objects in accordance with the teachings of the present invention.

DETAILED DESCRIPTION

In the following description, for purposes of explanation, numerous details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that these specific details are not required in order to practice the present invention. In other instances well known electrical structures and circuits are shown in block diagram form in order not to obscure the present invention unnecessarily.

The system of the present invention provides a user configurable Global Position System (GPS) receiver system in which the user application processing does not interfere with time critical positioning processing. A simplified block diagram is shown in **Figure 1**. The system and methods of the present invention are described below with reference to a GPS receiver. However, it is contemplated that the present invention can be implemented in a variety of positioning system receivers including GLONASS, Loran-C and Pseudo-lite receivers.

Referring to **Figure 1**, a GPS antenna and corresponding receiver circuitry **10** is connected to processor **15** via bus **20**. The processor **15** interacts with the GPS hardware such as the correlators, voltage control oscillator (VCO's) and the like, located in receiver **10** to acquire and track GPS signals transmitted by satellites. Thus, GPS receiver **10** receives GPS signals from satellites under the control of processor **15** acquires and tracks the satellites in order to receive the positioning signals. The processor **15** further processes the positioning signals to generate positioning data. Typically, the positioning data includes a time, angular and distance measurements. The specific data generated can vary according to implementation and is well

known in the art. Furthermore, the control functions performed by the processor to acquire and track signals are well known in the art and will not be discussed further herein.

As is well known in the art, positioning signal processing is time critical in nature. Therefore, delays in processing the positioning signals can cause significant error in the computations. Processor 15 not only performs position signal processing, but also performs user application processing. The code and data for the user application as well as the positioning signal code and data are preferably stored in memory 25, which is coupled to processor 15 via bus 20. It is contemplated that memory 25 may also be coupled to processor 15 through a separate bus (not shown). In addition, the system includes a variety of I/O devices, such as GPS antenna/receiver 10, a display 30 and at least one user input device input device 35, such as a keyboard or mouse. The use of these I/O devices is programmable according to the user application.

Figure 2 is a block diagram illustrating the process structure that enables the positioning signal processing to be performed without encumbrance by the user application processing. The processor is controlled by an operating system which receives the instructions of the executing processes and controls the processor accordingly.

Although not limited as such, in the present embodiment it is preferred that a real-time operating system 205 is used to address the time critical nature of the satellite signal processing. The operating system 205 is connected to the code 210 used to control the input/output devices including the GPS receiver. One example of a real-time operating system is the Vx Works® embedded operating system marketed by WindRiver Systems. The processor processes the satellite signals in accordance with the

GPS process 215. Thus, GPS process 215 interacts in the real-time manner with the real-time operating system 205 to receive positioning signals through I/O control 210 and controls the GPS receiver circuitry through I/O control 210 to accurately acquire and track the satellite signals.

5 As noted above it is desirable to enable the user to configure the system for the user's particular application. Therefore, in order to provide this capability, a firewall 220 is established between the GPS process 215, real-time operating system 205, and the user application 225.

10 In the present embodiment a virtual machine is used 230 to provide a level of protection from a user application program interfering with the data utilized in the GPS process 215. For example, the virtual machine 230 prohibits the user application process 225 from specifically accessing or corrupting a particular memory location not previously allocated to that application as the virtual machine acquires the application to address a
15 particular memory location using a virtual address. In addition, the application process must have the privilege of accessing that particular address. Thus, virtual machine 230 provides one level of the firewall 250.

20 A virtual machine is a software computer that executes programs that have been compiled into byte code. As noted above, the virtual machine separates the hardware and system software from the application software. Thus, system independent applications can be developed in any language that has a compiler that generates the virtual machine byte code. Applications once complied with byte code can be downloaded and executed as any processor that executes a virtual machine. One such virtual machine,
25 is the Java Virtual Machine, by Sunsoft, Mountain View, California.

 The firewall 250 further is required to prohibit the user application 225 from interfering with the time critical processing of the GPS process 215.

In order to protect against this potential problem, the user application processes, as executed by virtual machine 230, are set to a priority that is lower than the priority of the GPS process 215. For example, this is done by setting the priority of the GPS process to the highest priority in the operating system 205. Thus, any other process, such as the user application process will run at a lower priority, thus insuring that the GPS process 215 executes in a timely manner.

Continuing reference with **Figure 2**, in the present embodiment, an application programming interface (API) 240 is provided to simplify the user task of developing the user application. The API 240 preferably includes a number of functions that are accessible by the user application. In the present embodiment, the system is programmed using object oriented technology, such as C++; alternately the Java language can be used. **Figures 3a and 3b** illustrate the Java objects for getting information to perform routing processes. **Figures 4a - 4g** illustrate objects used to acquire time information from GPS signals. **Figure 5a** is illustrative of GPSfix objects that can be used to get location information, i.e., a "fix". In the present embodiment, it is preferred that the GPSfix classes are constructed as class hardwarefix or simfix, wherein class hardwarefix, when initialized, includes communication between the class and the hardware. Furthermore, the object created receives data from the GPS hardware receiver. Simfix is a class of superclass GPSfix that users can instantiate to obtain a simulated GPS fix. When the class is initialized (e.g., the first time it is used), a simulator is started that propagates meaningful positions over time. Furthermore, the class includes methods to deal with simulation, e.g., defining regions and dynamics of simulated data. Simfix is used to provide an applications developer with a realistic model of GPS data.

It is readily apparent that a system developer can provide a variety of objects to address potential user applications. Thus, the user in this embodiment is further isolated from the operating system **205** through the API **240**. The resulting system provides a system readily adaptable by a
5 variety of users for a variety of applications without the concern of interference of the time critical GPS processing.

The invention has been described in conjunction with the preferred embodiment. It is evident that numerous, alternatives, modifications, variations, and uses will be apparent to those skilled in the art in light of the
10 foregoing description.

CLAIMS

What is claimed is:

1 1. A positioning system comprising:
2 a receiver configured to receive positioning signals;
3 a processor configured to process the positioning signals in a real time
4 manner to generate positioning data;
5 user application code executed by the processor, said application code
6 configured to access the positioning data;
7 a firewall established between the processor and the user application
8 code, said firewall configured to prevent the user application code from
9 corrupting positioning data and enables the processor to process the
10 positioning signals in real time without interference by the user application
11 code.

1 2. The positioning system as set forth in claim 1, further
2 comprising an application programming interface (API), said API configured
3 to access the positioning data as instructed by the user application code.

1 3. The positioning system as set forth in claim 2, wherein the API
2 comprises a plurality of objects.

1 4. The positioning system as set forth in claim 1, wherein the
2 processor executes a real time operating system (RTOS).

1 10. The method as set forth in claim 7, wherein the firewall
2 comprises the steps of processing the positioning signals at a higher priority
3 than the accessing and processing the positioning data.

1 11. A computer readable medium containing executable
2 instructions which, when executed in a processing system, causes the system
3 to perform steps for processing positioning information, comprising:
4 receiving positioning signals;
5 processing the positioning signals in a real time manner to generate
6 positioning data;
7 accessing the positioning data through a firewall that prevents an
8 access from corrupting positioning data and interfering with the processing
9 of the positioning signals; and
10 processing the positioning data to generate user application data.

1 12. The computer readable medium as set forth in claim 11,
2 wherein the instructions further comprise a virtual machine, said step of
3 accessing comprising the steps of:
4 issuing instructions to the virtual machine; and
5 said virtual machine receiving the issued instructions and
6 performing the access in accordance with the issued instruction.

1 13. The computer readable medium as set forth in claim 11,
2 wherein the step of accessing comprises accessing the positioning data at a
3 lower priority than processing the positioning signals.

ABSTRACT

An extensible Global Positioning System (GPS) receiver system is described. The receiver system isolates user application processing from
5 time critical GPS acquisition and tracking processing in order to insure that GPS acquisition and tracking processing is timely performed. Thus user application processing can be developed without concern of conflict with GPS acquisition and tracking processing.

Attorney's Docket No.: 02240.P048

Patent

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Extensible GPS Receiver System

the specification of which

XX is attached hereto.
_____ was filed on _____ as
United States Application Number _____
or PCT International Application Number _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

[illegible]

(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

(Application Number)	Filing Date
(Application Number)	Filing Date

(Application Number)	Filing Date	(Status -- patented, pending, abandoned)
(Application Number)	Filing Date	(Status -- patented, pending, abandoned)

[illegible]

Inventor's Signature Peter F. Freeberg Date Nov 13, 1997

Post Office Address 22487 Santa Paula Avenue
Cupertino, CA 95014

Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made or record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:
Peter L. Froeberg
Application Number: not yet assigned
Filed: Herewith
For: EXTENSIBLE GPS RECEIVER SYSTEM

Assistant Commissioner for Patents
Washington, D.C. 20231

POWER OF ATTORNEY

Trimble Navigation Limited
 (Name of Assignee)
 ("assignee"), a California corporation having a place of
 (State of Incorporation)
 business at 645 North Mary Avenue, Sunnyvale, California 94086
 (Address)

certifies that to the best of assignee's knowledge and belief it is the assignee of the entire right, title, and interest in and to the above-referenced patent application and represents that the undersigned is a representative authorized and empowered to sign on behalf of the assignee.

Assignee has reviewed the assignment document (copy attached) that evidences the placement of title in the assignee and upon information and belief that the assignment document is being forwarded to the U.S. Patent and Trademark Office for recordation

Pursuant to 37 C.F.R. §§ 3.73 and 3.71, the assignee hereby appoints Aloysius T. C. AuYeung, Reg. No. 35,432; William Thomas Babbitt, Reg. No. 39,591; Jordan Michael Becker, Reg. No. 39,602; Bradley J. Berezna, Reg. No. 33,474; Michael A. Bernadicou, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; Gregory D. Caldwell, Reg. No. 39,926; Kent M. Chen, Reg. No. 39,630; Lawrence M. Cho, Reg. No. 39,942; Thomas M. Coester, Reg. No. 39,637; Roland B. Cortes, Reg. No. 39,152; William Donald Davis, Reg. No. 38,428; Michael Anthony DeSanctis, Reg. No. 39,957; Daniel M. De Vos, Reg. No. 37,813; Karen L. Feisthamel, Reg. No. 40,264; James Y. Go, Reg. No. P-40,621; Tarek N. Fahmi, Reg. No. P-41,402; David R. Halvorson, Reg. No. 33,395; Eric Ho, Reg. No. 39,711; George W. Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; Dag H. Johansen, Reg. No. 36,172; Stephen L. King, Reg. No. 19,180; Dolly M. Lee, Reg. No. 39,742; Michael J. Mallie, Reg. No. 36,591; Kimberley G. Nobles, Reg. No. 38,255; Ronald W. Reagin, Reg. No. 20,340; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195;

Charles E. Shemwell, Reg. No. 40,171; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Allan T. Sponseller, Reg. No. 38,318; Steven R. Sponseller, Reg. No. 39,384; Edwin H. Taylor, Reg. No. 25,129; Lester J. Vincent, Reg. No. 31,460; John Patrick Ward, Reg. No. 40,216; Ben J. Yorks, Reg. No. 33,609; and Norman Zafman, Reg. No. 26,250; my attorneys; and Robert Andrew Diehl, Reg. No. P-40,992; Sharmini Nathan Green, Reg. No. P-41,410; Thomas A. Hassing, Reg. No. 36,159; Edwin A. Sloane, Reg. No. 34,728; and Judith A. Szepesi, Reg. No. 39,393; my patent agents, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Pursuant to 37 C.F.R. § 3.71, the assignee hereby states that prosecution of the above-referenced patent application is to be conducted to the exclusion of the inventor(s).

Send all future correspondence to Maria McCormack Sobrino,

Reg. No. 31,639, Blakely, Sokoloff, Taylor, & Zafman LLP, 12400 Wilshire Boulevard, Seventh Floor, Los Angeles, California 90025, and direct all telephone calls to the same at (408) 720-8598.

Assignee of Interest: Trimble Navigation Limited

Dated: 11/13/97

By: James M. Janky (Type or Print)

Name: James M. Janky

(Type or Print)

Title: Vice President, Intellectual Property

(Type or Print)

Address of Assignee of Interest:

645 North Mary Avenue

Sunnyvale, California 94086

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: November 13, 1997 By Maria McCormack Sobrino

Name: Maria McCormack Sobrino

(Type)

Reg. No.: 31,639

12400 Wilshire Blvd.
Seventh Floor
Los Angeles, California 90025-1026
(408) 720-8598

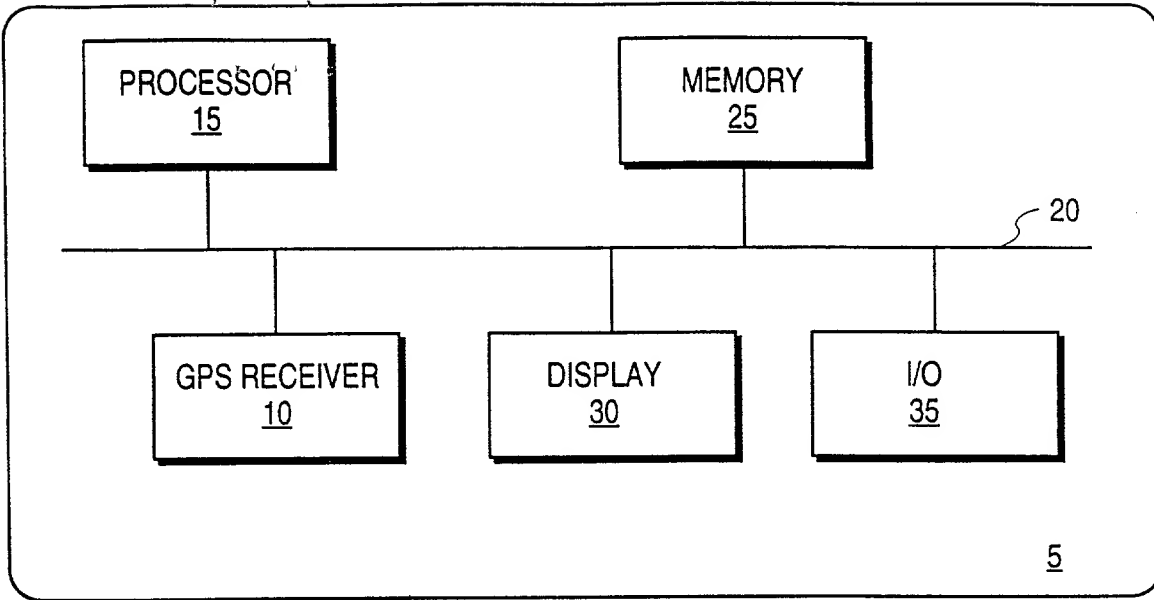


FIG. 1

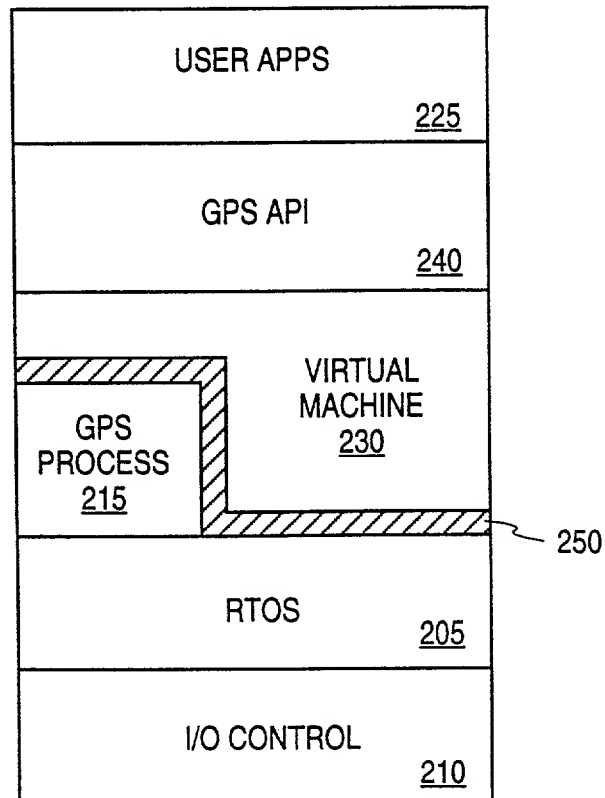


FIG. 2

CLASS GPS.ROUTEPOINT	
METHODS	
-getLat	public double getLat ()
-getLon	public double getLon ()
-getTime	public int getTime ()
-getRadius	public int getRadius ()
-getEarlyThreshold	public int getEarlyThreshold ()
-getLateThreshold	public int getLateThreshold ()
-getDistance	public double getDistance ()
-getIndex	public int getIndex ()
-setTime	
-setRadius	public void setRadius (int radius)
-setEarlyThreshold	public void setEarlyThreshold (int early)
-setLateThreshold	public void setLateThreshold (int late)
-setDistance	public void setDistance (double distance)

FIG. 3a

CLASS GPS.ROUTEPOINT	
METHODS	
-setIndex	public void setIndex (int index)
-toString	public String toString () Overrides: <u>toString</u> in class Object

FIG. 3b

CLASS GPS.GPSTIME	
VARIABLES	
-SECS_PER_WEEK	public static final int SECS_PER_WEEK
-SECS_PER_DAY	public static final int SECS_PER_DAY
-SECS_PER_HOUR	public static final int SECS_PER_HOUR
-SECS_PER_MINUTE	public static final int SECS_PER_MINUTE
-MINS_PER_HOUR	public static final int MINS_PER_HOUR
-HOURS_PER_DAY	public static final int HOURS_PER_DAY
-DAYS_PER_WEEK	public static final int DAYS_PER_WEEK

FIG. 4a

CLASS GPS.GPSTIME		
CONSTRUCTORS		
-GPSTime	public GPSTime ()	Constructs a GPSTime object with the current date and time
-GPSTime	public GPSTime (int yyyy, int m, int d)	Constructs a specific GPSTime given only the date Parameters: yyyy - year (full year, e.g., 1996, <i>not</i> starting from 1900) m - month (1-12) d - day (1-31) Throws: IllegalArgumentException if yyyy/m/d h:min:ss not a valid date/time
-GPSTime	public GPSTime (int yyyy, int m, int d, int h, int min, float s)	Constructs a specific GPSTime given a date & time Parameters: yyyy - year (full year, e.g., 1996, <i>not</i> starting from 1900) h - hour (range 0-23) min - minute (range 0-59) s - second (range 0-59.999...) Throws: IllegalArgumentException if yyyy/m/d h:ss not a valid date/time

FIG. 4b

CLASS GPS.GPSTIME		
CONSTRUCTORS, cont.		
-GPSTime	public GPSTime (short week_tag, float time_tag)	<p>Constructs a specific GPSTime given the GPS week/second tags. This method corrects for UTC leap seconds and performs GPS week rollover checking according to the current rollover threshold currently in effect</p> <p>Parameters:</p> <p>week_tag - GPS week number (range 0 to 1023)</p> <p>time_tag - Seconds into the GPS week (not adjusted for UTC)</p>

FIG. 4c

CLASS GPS.GPSTIME		
METHODS		
-advanceDay	public void advanceDay (int n)	Advance by n days. For example. d.advanceDay(30) adds thirty days to d Parameters: n - the number of days by which to change this (n can be < 0)
-advanceSecond	public void advanceSecond (float n)	Advance the time by n 'seconds'. For example. d.advanceSecond(30) adds thirty seconds to d Parameters: n - the number of seconds by which to change this day (can be < 0)
-getSecond	public float getSecond ()	Gets the second of the minute Returns: the second of the minute (range 0 to 59.999...)
-getMinute	public int getMinute ()	Gets the minute of the hour Returns: the minute of the hour (range 0 to 59)
-getHour	public int getHour ()	Gets the hour of the day Returns: the hour of the day (range 0 to 23)

FIG. 4d

CLASS GPS.GPSTIME		
METHODS cont.		
-getDay	public int getDay ()	Gets the day of the month Returns: the day of the month (range 0 to 31, month dependent)
-getMonth	public int getMonth ()	Gets the month Returns: the month (range 1 to 12)
-getYear	public int getYear ()	Gets the year Returns: the year (counting from 0, <i>not</i> 1900)
-weekday	public int weekday ()	Gets the weekday Returns: the weekday (0 = Sunday, 1 = Monday, ... , 6 = Saturday)
-daysBetween	public int daysBetween (GPSTime b)	The number of days between this and GPSTime parameter Parameters: b - any GPSTime Returns: the number of days between this and GPSTime parameter and b (> 0 if this day comes after b)

FIG. 4e

CLASS GPSTIME		
METHODS cont.		
-secsBetween	public double secsBetween (<u>GPSTime</u> b)	<p>The number of seconds between this and GPSTime parameter</p> <p>Parameters: b - any GPSTime</p> <p>Returns: the number of seconds between this and GPSTime parameter and b (> 0 if this comes after b)</p>
-getWeek_tag	public short getWeek_tag ()	<p>Get the GPS week_tag</p> <p>Returns: the GPSTime_tag value (aliased to lie from 0 - 1023)</p>
-getTime_tag	public float getTime_tag ()	<p>Get the GPS time_tag</p> <p>Returns: the GPSTime_tag value (offset from UTC by GPS leap seconds)</p>
-convertGPSTimetag	public void convertGPSTimetag (short week_tag, float time_tag)	<p>Set this GPSTime to the GPS week/seconds tags. This method corrects for UTC leap seconds and performs GPS week rollover according to the current rollover threshold currently in effect</p> <p>Parameters: week_tag - GPS week number (range 0 to 1023) time_tag - Seconds into the GPS week (not adjusted for UTC)</p>

FIG. 4f

CLASS GPS.GPSTIME		
METHODS cont.		
-toString	public String toString ()	<p>A string representation of the day</p> <p>Returns: a string representation of the GPS date and time</p> <p>Overrides: <u>toString</u> in class Object</p>
-DurationString	public static String DurationString (int dt)	<p>A string representation of a duration in seconds</p> <p>Parameters: dt - Delta time in seconds</p> <p>Returns: a string representation of the delta seconds parameter</p>
-toCalendar	public Calendar toCalendar ()	<p>Convert to Java Calendar object using the default Time zone and locale GPS seconds round to the nearest integer second</p>
-clone	public Object clone ()	<p>Makes a bitwise copy of a GPSTime object</p> <p>Returns: a bitwise copy of a GPSTime object</p> <p>Overrides: <u>clone</u> in class Object</p>
-main	public static void main (String args [])	

FIG. 4g

CLASS GPS.GPSFIX		
METHODS		
-clone	public Object clone ()	Makes a bitwise copy of a GpsFix object Returns: a bitwise copy of a SimFix object TBD: sub-objects must also support cloning and be explicitly cloned here. Overrides: clone in class Object.
-getDGPSflag	public boolean getDGPSflag ()	Get the Differential GPS status of the current fix. A TRUE value may be either 2D or 3D.
-GetLatitude	public double GetLatitude ()	Get the latitude in degrees referenced to WGS-84 Positive values indicate northern hemisphere. Negative values indicate southern hemisphere.
-GetLongitude	public double GetLongitude ()	Get the longitude in degrees referenced WGS-84 Negative values indicate western hemisphere. Positive values indicate eastern hemisphere.
-GetAltitudeMSL	public double GetAltitudeMSL ()	Get the altitude in meters above the geoid (mean sea-level)
-getAltitudeWGS84	public double getAltitudeWGS84 ()	Get the altitude in meters above the WGS-84 ellipsoid.
-getTimeTag	public float getTimeTag ()	Get the GPS time tag as seconds within the GPS week.

FIG. 5a

CLASS GPS.GPSFIX		
METHODS cont.		
-getWeekTag	public short getWeekTag ()	Get the GPS week tag (0-1023) from the GPS epoch. This epoch is nominally Jan 6, 1980, but can be adjusted accordingly within the GPSTime class.
-getTimeOffset	public GPSTime getTimeOffset ()	Return the UTC (leap-second corrected) time of current fix.
-AgeOfFix	public double AgeOfFix ()	Get the age of the current fix in seconds as compared to (GPS-corrected) system time.
-TimeSincePreviousFix	public float TimeSincePreviousFix (GpsFix prefix)	Return the number of seconds between this fix and the specified (prior) fix.
-GetSpeed	public float GetSpeed ()	Return the horizontal speed in meters per second.
-GetHeading	public float GetHeading ()	Return the current "course" in degrees clockwise from the true north.
-GetVspeed	public float GetVspeed ()	Return the vertical speed in meters per second.
-equals	public boolean equals (GpsFix f)	Return true if fixes are equal.
-print	public void print (String s)	
-print	public void print ()	

FIG. 5b